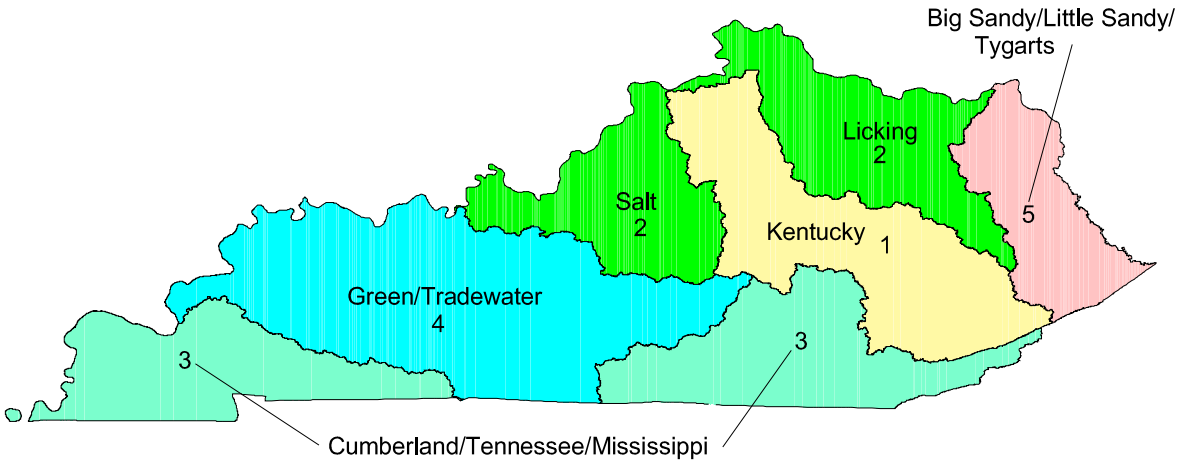
2002 Kentucky Report to Congress on Water Quality

with emphasis on the Salt/Licking and
Cumberland/Tennessee/Mississippi
Basin Management Units



Kentucky Natural Resources and
Environmental Protection Cabinet
Division of Water
September 2002

ACKNOWLDGEMENTS

This report includes the second and third years of an intensive inter-agency watershed monitoring effort with the support of state, federal, and local agencies. There are many people and organizations to thank for continuing to support this important effort. In particular, I wish to thank the Kentucky Department of Fish and Wildlife Resources and their district fisheries personnel for their substantial contribution. The U.S. Forest Service, Kentucky State Nature Preserves Commission, U.S. Fish and Wildlife Service, and the Nashville and Louisville districts of the U.S. Army Corps of Engineers contributed to both the planning and carrying out of the monitoring. The Kentucky Division of Environmental Services conducted the analyses of all surface water quality samples submitted by the Division of Water. Staff in the London, Hazard, Columbia, Bowling Green, Madisonville, and Paducah offices of the Field Operations Branch collected many of the surface water samples and analyzed many of the bacteria samples. Louisville's Metropolitan Sewer District provided data on waters in the greater Louisville area. The Nonpoint Source Program of the Kentucky Division of Water funded biological work by Eastern Kentucky University in the Sinking Creek and Buck Creek watersheds and biological and bacteria sampling by Murray State University in the Lower Cumberland and Tennessee river basins. Personnel from the Natural Resources Conservation Service, Kentucky Geological Survey, Kentucky Division of Conservation, Kentucky Division of Pesticides, Kentucky Division of Forestry, Kentucky Water Resources Research Institute, and the U.S. Geological Survey were involved in important planning stages. The USEPA National Health and Environmental Effects Research Laboratory in Corvallis, Oregon provided the random survey sampling design and analysis. Lee Colten, the Kentucky Division of Water's Watershed Coordinator, has worked diligently to promote the watershed effort. Steve Bolssen assisted in GIS applications. Last, but certainly not least, I want to thank all the staff of the Water Quality and Groundwater branches of the Kentucky Division of Water, including secretaries Dru Ellen Hawkins and Mariam Wiley, for their work.

Tom C. Van Arsdall
Kentucky 305(b) Coordinator
June 2002

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Chapter 1. Introduction

This report was prepared by the Kentucky Division of Water (DOW) for submittal to the U.S. Environmental Protection Agency (EPA) to fulfill requirements of Section 305(b) of the Federal Water Pollution Control (or Clean Water) Act of 1972 (P.L. 92-500), as subsequently amended. Section 305(b) of the Act requires states to assess and report current water quality conditions to EPA every two years.

The DOW initiated a five-year rotating watershed management approach in 1997. Results from the first basin management unit, the Kentucky River, were reported in the 2000 305(b) report. The current (2002) report consists primarily of results from monitoring in the second and third basin management units, the Salt/Licking unit in 1999 and the Cumberland/Tennessee/ Mississippi unit in 2000, and it also presents a summary of data from the entire state. Therefore, this report includes results of not only three years of intensive watershed data collection but also data collected prior to 1998 in the two basin management units that have not yet been sampled intensively (Green/Tradewater unit and Big Sandy/Little Sandy/Tygarts unit). Data collected by the Ohio River Valley Water Sanitation Commission (ORSANCO) were used to make assessments for the main stem of the Ohio River.

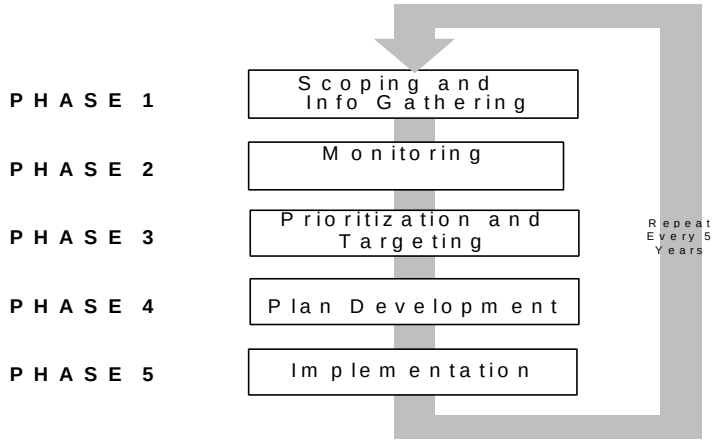
Most impaired waters identified by this report also are listed in the 2002 303(d) report (Kentucky Division of Water 2002a). However, there are reasons that some impaired waters are not 303(d)-listed. For example, compliance problems at facilities with adequate permits are not on the 303(d) report because the total maximum daily load (TMDL) has already been calculated and accounted for in the permit. These issues are discussed in more detail in the 303(d) report.

Chapter 2. Watershed Management Framework

In order to better characterize the waters of the state and better coordinate resources toward addressing problems, Kentucky adopted a Watershed Management Framework in 1997. The purpose of this management framework is to use programs, people, information, and funds as efficiently as possible to protect, maintain, and restore water and land resources. This approach provides a framework in place and time within which participating individuals and institutions can link and support one another's efforts in watershed management.

According to the adopted framework, the state is divided into five basin management units (see Figure 2-1 and Schedule below) for the purposes of focusing management activities spatially. Activities within each unit follow a five-year schedule, staggered by one year, so that efforts can be better focused temporally within a basin. Phases in the cycle include collecting information about water resources in the basin, identifying priority watersheds, listing the watersheds in the basin in order of priority and deciding which problems can be solved with existing funds, determining how best to solve the problems in the watershed, developing an action plan, and carrying out the strategies in the plan. Public participation is also encouraged throughout the process, allowing citizens and organizations to stay informed and have an active role in management of the resource.

Monitoring and assessment take place in the second and third years, respectively, of the watershed cycle.



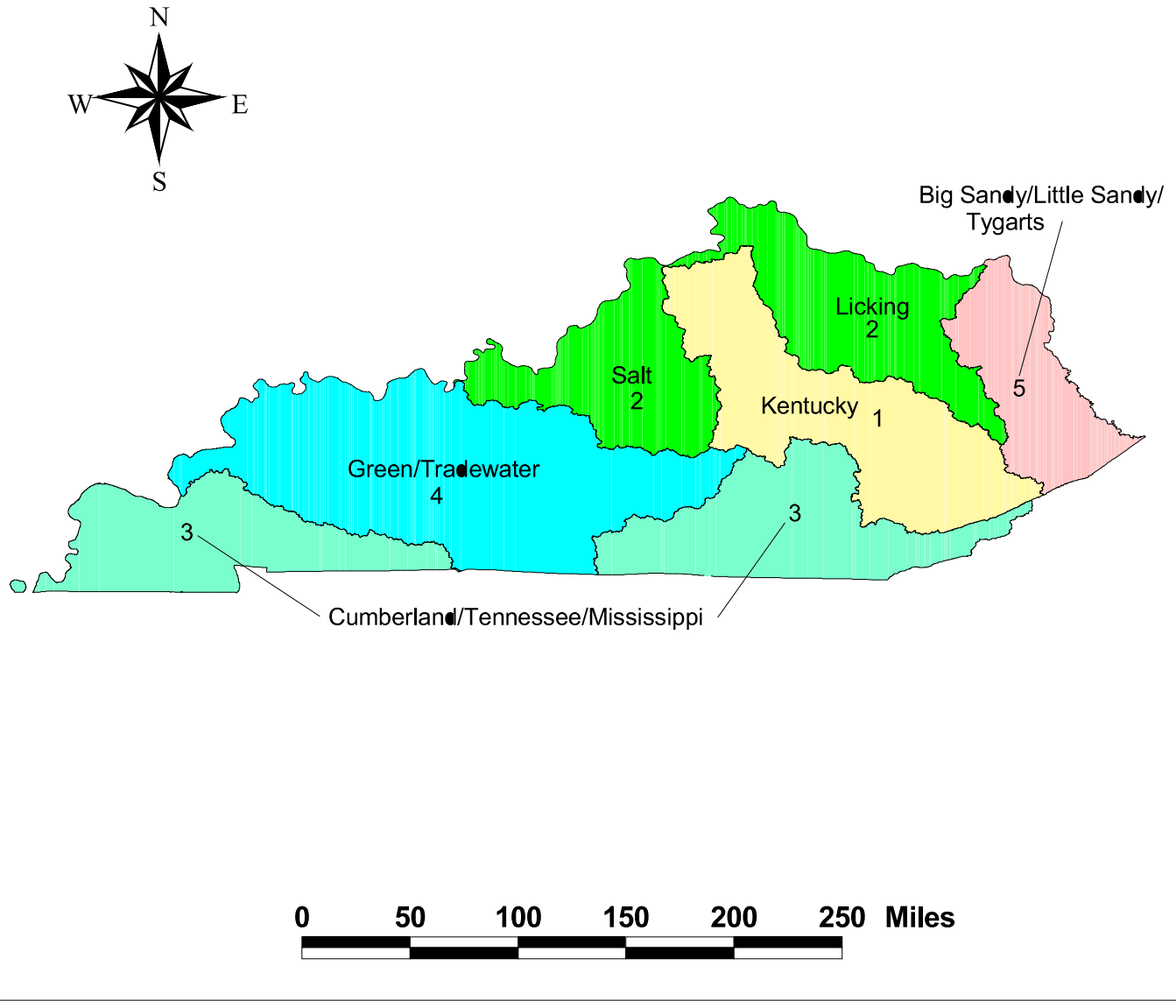
Each basin was phased into the Watershed Framework schedule as listed below. Monitoring activities begin in the second year of the cycle.

- July 1997 – Kentucky River basin
- July 1998 – Salt and Licking river basins
- July 1999 – Cumberland, Tennessee, and Mississippi river basins
- July 2000 – Green and Tradewater river basins
- July 2001 – Big Sandy River, Little Sandy River , and Tygarts Creek Basins

Benefits of this approach include:

- Better coordination of resource management activities around common basin management units and schedules
- Better ability to stretch limited dollars for implementation activities through partnering
- Better information about water resources without higher monitoring costs
- More data as monitoring efforts are coordinated – approximately a four-fold increase in assessment data has been realized since the inception of the watershed approach in 1998
- Better data as agencies standardize methods and procedures
- Greater opportunities for citizen involvement

Figure 2-1. Kentucky Basin Management Units



Chapter 3. Rivers and Streams

3.1 Data Collection

The water quality assessments of rivers and streams were based on the support of designated uses in waters depicted on U.S. Geological Survey (USGS) 1:100,000 scale topographic maps. According to EPA's National Hydrologic Dataset (NHD), these maps contain 49,171 stream miles for the entire state - 10,728 miles in the Salt/Licking unit and 12,741 miles in the Cumberland unit, distributed as follows in the major river basins:

Salt River basin (incl. Ohio River minor tributaries) ……4,425
Licking River basin (incl. Ohio River minor tributaries)……...6,303
Upper Cumberland River basin……..6,539
Lower Cumberland River basin……..1,951
Tennessee River basin (incl. Ohio River minor tributaries)…….. 2,108
Mississippi River basin ……2,143

For this report, monitoring occurred in 21 of the state's 42 8-digit hydrologic (cataloging) units established by the U.S. Geological Survey (Figure 3-1). In the Licking River basin, 164 reaches on 105 streams were assessed (Figure 3-2), and 124 reaches on 86 streams were assessed in the Salt River basin (Figure 3-3). Totals for both these basins include the adjacent Ohio River minor tributaries. In the Cumberland unit, 244 reaches on 176 streams were assessed in the upper part of the unit (Figures 3-4 and 3-5), and 207 reaches on 138 streams were assessed in the lower part of the unit (Figure 3-6). Most of these assessments stemmed from intensive multi-agency watershed monitoring in 1999 and 2000. However, some data more than five years old were considered valid and were used for this reporting period, and some data were collected after 2000.

Volunteer monitoring bacteria data were used as a screening tool but were not used directly in assessments of use support. Additional bacteria data collections were made by the DOW and Section 319(h)-funded contractors on many of the streams identified as problematic by the volunteer data. As the volunteer monitoring program evolves, the DOW will review the manner in which these data are used.

Figure 3-1. 8-Digit HUCs Monitored in the Salt/Licking and Cumberland/Tennessee/Mississippi Basin Management Units

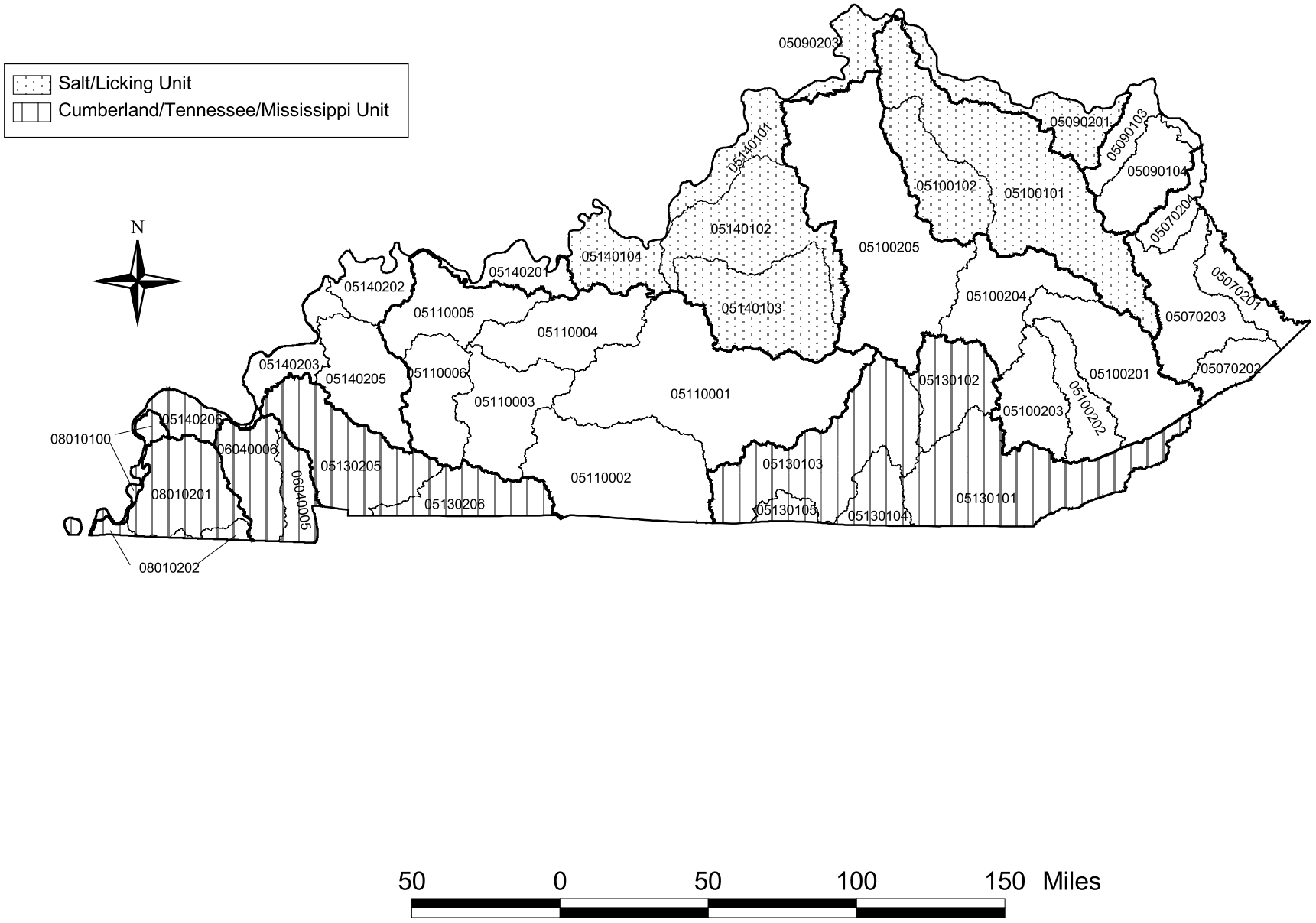


Figure 3-2. Monitoring Sites - Licking River Basin

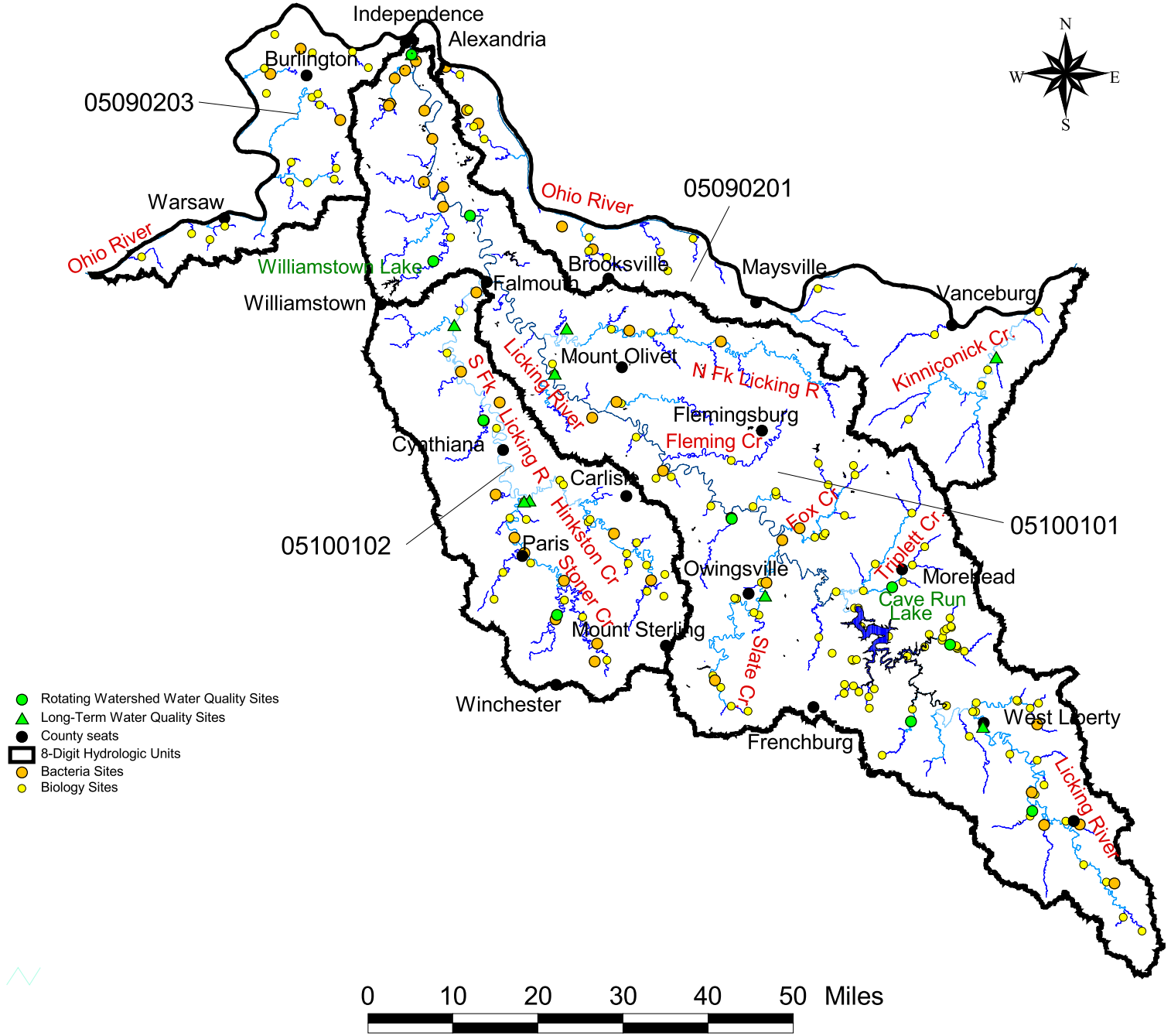


Figure 3-3. Monitoring Sites - Salt River Basin

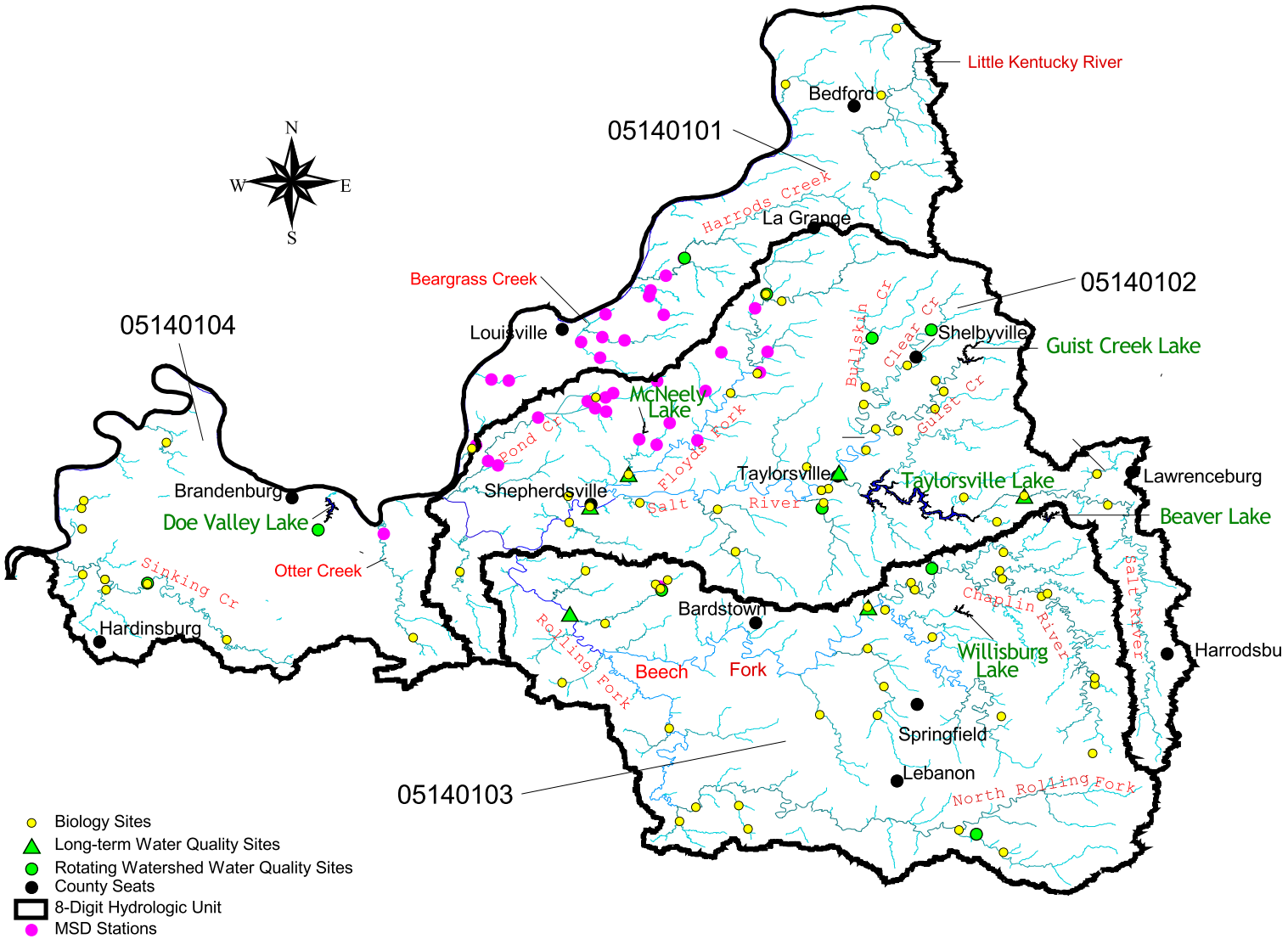


Figure 3-4. Monitoring Sites - Upper Cumberland River Basin - Hydrologic Unit 05130101

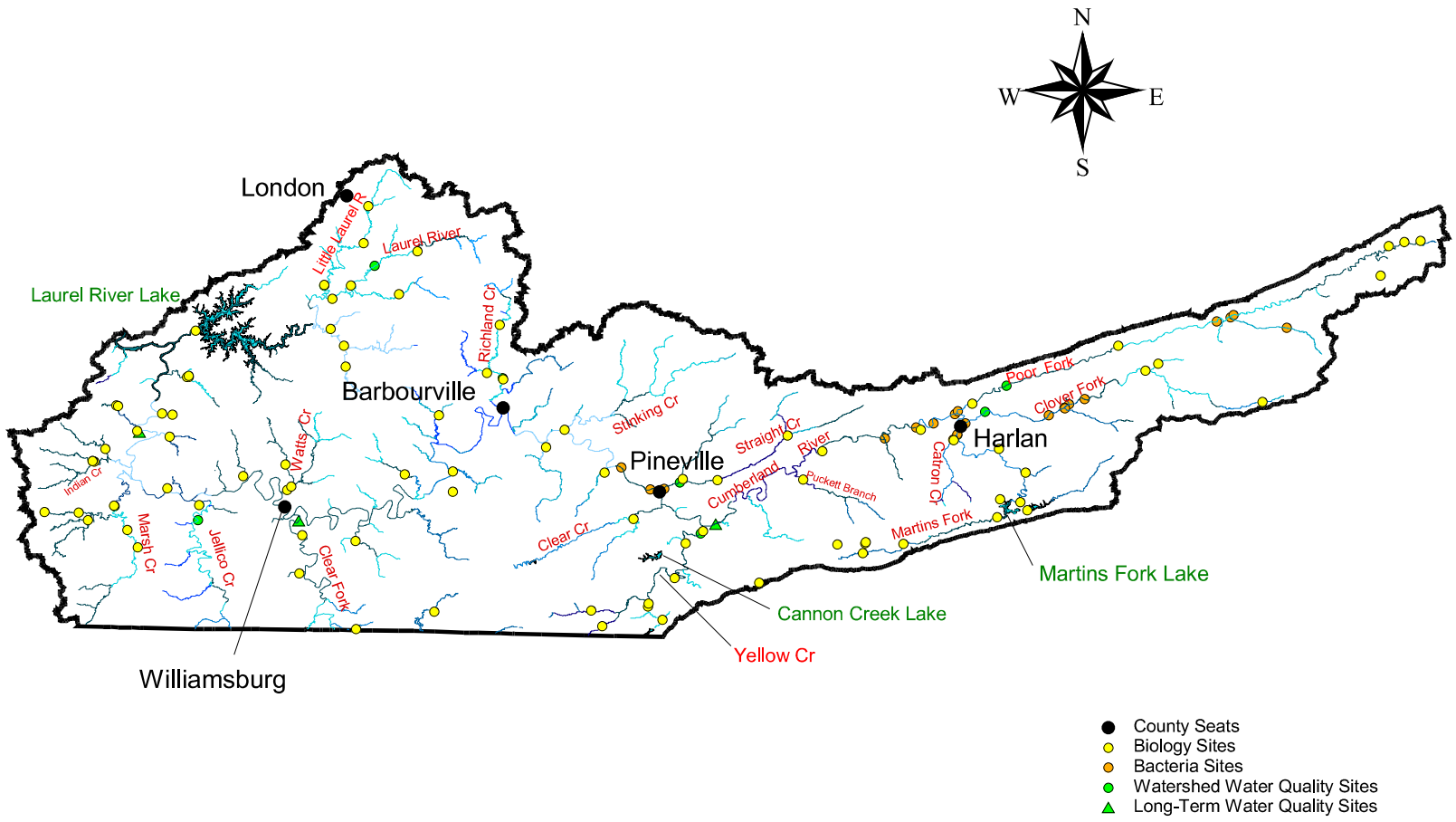


Figure 3-5. Monitoring Sites - Upper Cumberland River Basin - Hydrologic Units 05130102- 05

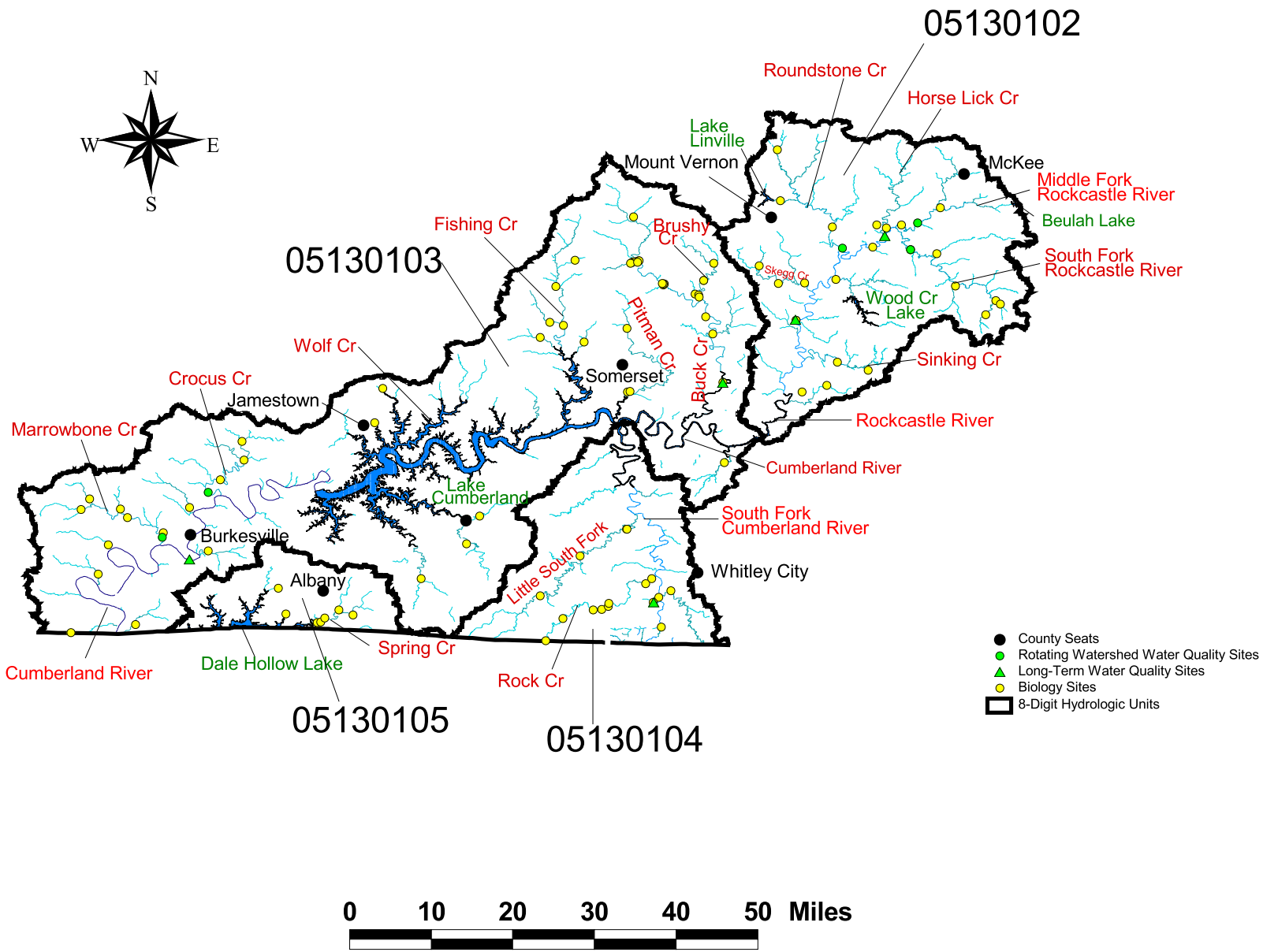
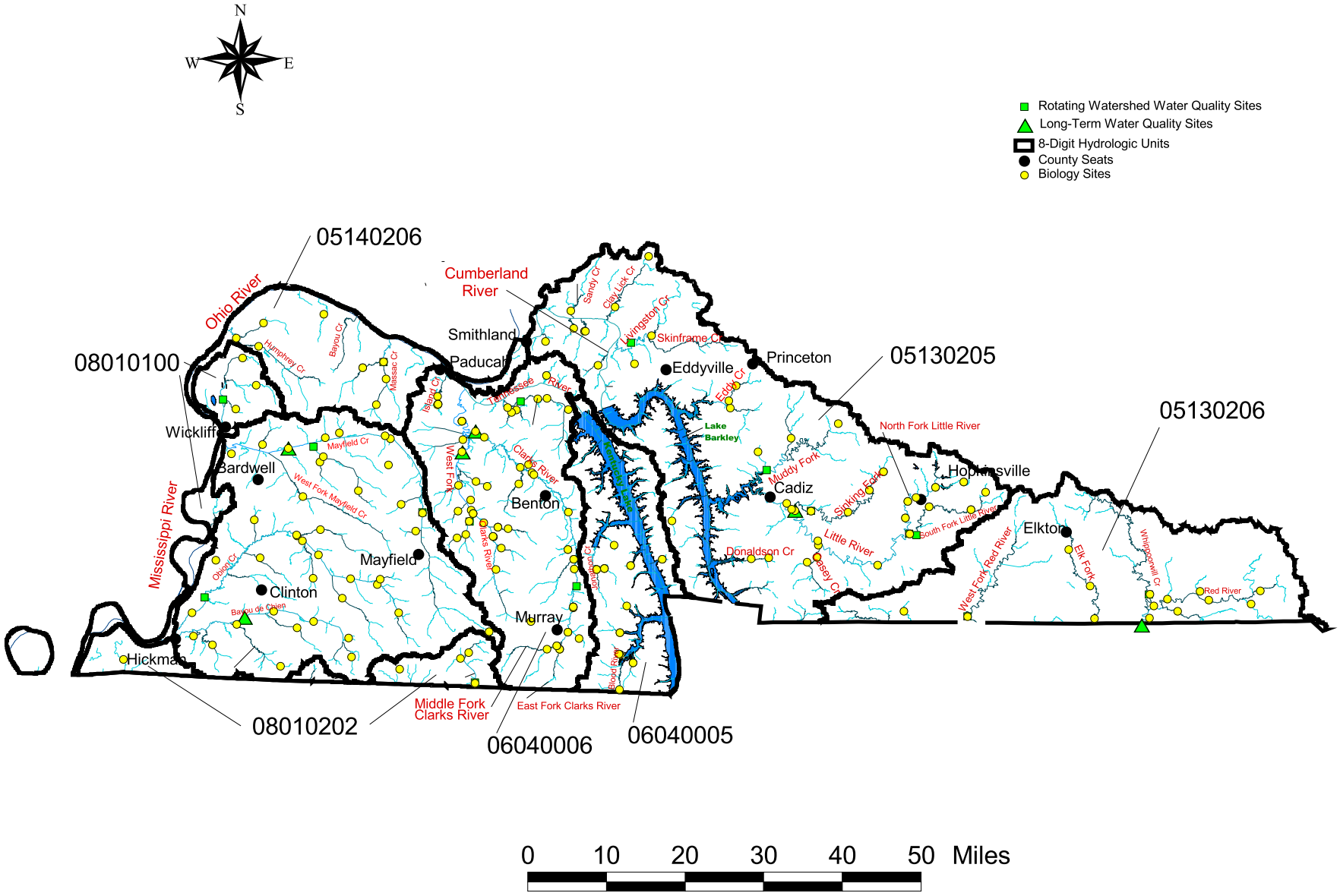


Figure 3-6. Monitoring Sites - Lower Cumberland, Tennessee and Mississippi River Basins



3.1.1 Ambient (Long-Term) Monitoring Network

Water Quality. DOW's statewide ambient water quality monitoring network was increased from 44 to 70 fixed stations with the initiation of intensive monitoring under the watershed approach in May 1998. Ambient stations are located in the downstream and mid-unit reaches of USGS 8-digit hydrologic (cataloging) units, upstream of major reservoirs, and in the downstream reaches of major tributaries. Each of the two basin management units contains 14 ambient stations (Table 3-1). The ambient stations of a particular watershed management unit are sampled monthly during the year the unit is in the monitoring phase of the watershed cycle. During the other four years of the watershed cycle, sampling frequency is reduced to bimonthly to devote more monitoring and laboratory resources to the rotating watershed water quality network (described later). Field measurements are taken for pH, dissolved oxygen, specific conductance, and temperature, and samples are analyzed for nutrients, metals, and also pesticides and herbicides if the streams are in predominantly agricultural areas. The purpose of the ambient water quality sampling is to assess long-term conditions and trends on rivers and the larger streams of the state.

In addition to DOW's network, long-term stations are maintained by ORSANCO on the lower Licking and Cumberland rivers and by the USGS on the lower Tennessee River.

Sediment Quality. Sediment quality is determined at the ambient stations during the year in which monitoring occurs in a watershed management unit. At this time, sediment data supplement other data types; the data are not used directly in assessments of use support.

Biology. Fish, macroinvertebrate, and algae data from the ambient stations provide long-term and trend information on mainstem rivers and many major tributaries. These stations will be revisited every five years. Most of the ambient biological stations are located on streams that also have water quality monitoring. Four of the ambient water quality stations at large river sites (three on the Cumberland and one on the Tennessee) were not sampled biologically because of the lack of adequate biological indices and the difficulty in obtaining representative samples from all habitats in large rivers.

Fish Tissue. Fish tissue samples were obtained from 14 sites in the Cumberland unit and 26 sites in the Salt/Licking unit. Tissue was analyzed for metals, including mercury, PCBs,

Table 3-1. Kentucky Primary Water Quality Monitoring Stations[a]

Major River Basin	Station	Hydro Unit	Mile-Point	Location	Latitude	Longitude	Drainage Area (mi^2)
Big Sandy							
Tug Fork	2	05070201	35.1	at Kermit, WV	37 50 16	82 24 35	1280
Tug Fork	3	05070201	77.7	at Freeburn	37 33 58	82 08 38	271
Levisa Fork	6	05070202	115	nr Pikeville	37 27 51	82 31 33	1232
Levisa Fork	64	05070203	29.6	nr Louisa	38 04 50	82 36 01	2326
Levisa Fork	94	05070203	75	at Auxier	37 43 44.2	82 45 16.1	1726
Beaver Creek	95	05070203	1	Allen	37 36 09.6	82 43 39.4	240
Johns Creek	96	05070203	26.6	at McCombs	37 39 19.1	82 31 33.2	168
Little Sandy							
Little Sandy River	49	05090104	13.2	Argillite	38 29 26	82 50 03	522
Tygarts Creek							
Tygarts Creek	48	05090103	23.5	nr Lynn	38 35 58.9	82 57 10.1	242
Ohio River Tributaries							
Kinniconick Creek	63	05090201	10.4	nr Tannery	38 32 37	83 13 28	230
Licking River							
Licking River	62	05100101	226	at West Liberty	37 54 53	83 15 43	335
Slate Creek	93	05100101	10	nr Owingsville	38 08 29.3	83 43 43	230
Licking River	61	05100101	78.2	at Claysville	38 31 14	84 11 00	1993
North Fork Licking River	60	05100101	6.9	nr Milford	38 35 50	84 09 20	290
South Fork Licking River	59	05100102	11.7	at Morgan	38 36 12	84 24 03	839
Hinkston Creek	102	05100102	0.2	at Ruddles Mill	38 18 16.6	84 14 16.5	260
Stoner Creek	101	05100102	0.6	nr Ruddles Mill	38 18 10.3	84 14 58.9	284
Salt River							
Salt River	29	05140102	22.9	at Sheperdsville	37 59 06	85 43 03	1197
Salt River	52	05140102	82.5	at Glensboro	38 00 08	85 03 35	172
Brashears Creek	105	05140102	1.2	at Taylorsville	38 02 14	85 20 26	262
Floyds Fork	100	05140102	7.4	nr Sheperdsville	38 02 06	85 39 34	259
Rolling Fork	57	05140103	12.3	nr Lebanon Jct	37 49 23	85 44 53	1375
Beech Fork	41	05140103	48.0	nr Maud	37 49 58	85 17 46	436
Kentucky River							
Eagle Creek	22	05100205	21.5	Glencoe	38 42 22	84 49 32	437
Kentucky River	24	05100205	64.8	Frankfort	38 12 46.3	84 52 21.5	5412
Kentucky River	66	05100205	30.5	Lockport	38 26 42	84 57 25	6180

Table 3-1 (cont)

Major River Basin	Station	Hydro Unit	Mile-Point	Location	Latitude	Longitude	Drainage Area (mi2)	Type
Cumberland River								
Cumberland River	**86**	**05130101**	**661**	**at Calvin**	**36 43 19.7**	**83 37 31.9**	**770**	**mid-hydrologic unit index site**
Cumberland River	**9**	**05130101**	**563**	**at Cumberland Falls**	**36 50 08**	**84 20 25**	**1977**	**hydrologic unit index site**
Cumberland River	**87**	**05130101**	**0.9**	**nr Williamsburg**	**36 43 33.2**	**84 08 32.6**	**370**	**major tributary**
Rockcastle River	**10**	**05130102**	**24.7**	**at Billows**	**37 10 17**	**84 17 48**	**604**	**hydrologic unit index site**
Horse Lick Creek	**51**	**05130102**	**0.1**	**nr Lamero**	**37 19 13.3**	**84 08 19.2**	**62**	**special interest watershed**
Cumberland River	**7**	**05130103**	**423**	**nr Burkesville**	**36 44 46.5**	**85 22 18.2**	**6053**	**hydrologic unit index site**
Buck Creek	**88**	**05130103**	**12.3**	**nr Dykes**	**37 03 36.3**	**84 25 34.9**	**294**	**major tributary**
South Fork Cumberland R	**8**	**05130104**	**44.8**	**at Blue Heron**	**36 40 13**	**84 32 56**	**954**	**hydrologic unit index site**
Little River	**43**	**05130205**	**24.4**	**nr Cadiz**	**36 50 26**	**87 46 39**	**269**	**major tributary**
Red River	**69**	**05130205**	**49**	**nr Keysburg**	**36 38 26.9**	**86 58 44.7**	**509**	**hydrologic unit index site**
Green River								
Green River	18	05110001	226	at Munfordville	37 16 07.2	85 53 07.0	1673	hydrologic unit index site
Green River	76	05110001	334	nr Neatsville	37 11 30.9	85 07 49.1	339	major reservoir inflow
Nolin River	21	05110001	80.9	at White Mills	37 33 18	86 01 52	357	major reservoir inflow; major trib
Russell Creek	77	05110001	10	nr Bramlett	37 10 04.1	85 28 12.6	289	major tributary
Little Barren River	78	05110001	6.3	nr Monroe	37 13 35.2	85 40 39.2	256	major tributary
Bear Creek	75	05110001	11.8	nr Huff	37 14 55.8	86 21 40.4	159	major tributary
Barren River	72	05110002	1	Woodbury	37 10 23.8	86 37 23.5	1968	hydrologic unit index site
Barren River	73	05110002	114	nr Holland	36 41 46.8	86 02 48.2	398	major reservoir inflow
Drakes Creek	74	05110002	8	nr Bowling Green	36 56 05.7	86 23 34.7	502	major tributary
Green River	55	05110003	72	at Livermore	37 29 03.1	87 08 04.0	6431	hydrologic unit index site
Mud River	56	05110003	17.4	nr Gus	37 07 24	86 54 02	268	major tributary
Green River	103	05110003	150	nr Woodbury	37 11 00.4	86.36.57.5	3140	hydrologic unit index site
Rough River	14	05110004	62.5	nr Dundee	37 33 46	86 46 15	757	mid-hydrologic unit index site
Rough River	54	05110004	1	nr Livermore	37 29 03.1	87 07 07.6	1068	hydrologic unit index site
Panther Creek	70	05110005	5.4		37 43 38.3	87 16 50.5	374	major tributary
Pond River	12	05110006	12.4	nr Sacramento	37 23 42	83 41 36	523	hydrologic unit index site
Ohio River Tributaries								
Highland Creek	71	05140102	5.5	nr Uniontown	37 47 00.7	87 52 08.5	237	major tributary
Tradewater River								
Tradewater River	53	05140205	15.1	nr Sullivan	37 28 46.0	87 57 13	861	hydrologic unit index site
Tennessee River								
Clarks River	**106**	**06040006**	**14.3**	**nr Sharpe**	**36 58 18.5**	**88 30 53.9**		**hydrologic unit index site**
West Fork Clarks River	**107**	**06040006**	**7.8**	**nr Symsonia**	**36 55 56.9**	**88 32 37.6**		**major trib**
Mississippi River								
Bayou de Chien	**37**	**08010201**		**nr Moscow**	**36 36 54.8**	**89 01 48.4**	**69**	**major tributary**
Mayfield Creek	**42**	**08010201**	**10.8**	**nr Magee Springs**	**36 55 47.6**	**88 56 34.7**	**300**	**major tributary**

*Stations in bold are in Salt/Licking and Cumberland/Tennessee/Mississippi basin management units

chlordane, and pesticides and herbicides. Results were used to determine if there are potential problems with contaminants in fish tissue that required further sampling. If results were not elevated, no further fish tissue sampling was conducted.

Other Water Quality Monitoring. Louisville's Metropolitan Sewer District (MSD 2000) sampled water quality including bacteria at 26 sites in Jefferson and adjacent counties (Figure 3-3).

3.1.2 Rotating Watershed Network

Water Quality. An inter-agency monitoring team established several objectives for the one-year watershed water quality monitoring stations. The objectives were to: (1) obtain an overall representation of the quality of the basin's water resources; (2) determine water quality conditions associated with major land cover/land uses such as forest, urban, agriculture, and mining; (3) characterize the basin's least impacted waters; and (4) collect data for establishing total maximum daily loads (TMDLs) as required by Section 303(d) of the Clean Water Act. Parameters analyzed were similar to those described earlier for the ambient network.

The Division of Environmental Services, the laboratory of the Kentucky Natural Resources and Environmental Protection Cabinet, analyzed water quality samples collected by the DOW. The rotating watershed water quality monitoring network consisted of 20 stations in the Salt/Licking unit and 33 in the Cumberland unit (Table 3-2). These usually were located at the downstream reaches of USGS 11-digit watersheds, and many were coupled with biological sampling and with USGS gaging stations. Monthly sampling, sometimes complemented by rain event sampling, was conducted over the 12-month watershed monitoring phase (April 1999 – March 2000 in the Salt/Licking unit and April 2000 – March 2001 in the Cumberland unit) to characterize the watershed represented by the sample site.

Section 319(h) nonpoint source grant monies were used to fund additional bacteriological monitoring by Morehead State University at 42 sites in the Licking River basin and adjacent Ohio River minor tributaries (Pass et al. 2000) and Murray State University at 33 sites in the Lower Cumberland, Tennessee, and Mississippi river basins (White et al. 2001). Site selection was based largely on bacteria problems indicated from data collected by the basin volunteer Watershed Watch groups and to obtain data on streams with recreation potential. Also, DOW

Table 3-2. Rotating Watershed Water Quality Sites - April 1999 to March 2001

Site ID	Stream	Latitude	Longitude	Milepoint	Description
		Licking River Basin (4/99 - 3/00)			
LRW001	Licking River	39.0631	-84.4954	2.0	upstream of Newport Steel loading area
LRW002	Licking River	38.7898	-84.3674	35.0	KY 177 bridge, Butler, KY
LRW003	South Fork Grassy Creek	38.712	-84.4469	15.3	Straight Shoot Road bridge
LRW004	Mill Creek	38.4413	-84.337	2.9	Poindexter Road bridge
LRW005	Strodes Creek	38.1093	-84.178	12.4	KY 57 bridge
LRW006	Flat Creek	38.2721	-83.8001	0.7	KY 1325 bridge
LRW007	Triplett Creek	38.1537	-83.4547	10.6	KY 2342 bridge
LRW008	Blackwater Creek	37.925	-83.4162	5.4	KY 1950 bridge
LRW009	North Fork	38.055	-83.3307	11.5	sampled off Leisure - Paragon Road
LRW010	Johnson Creek	37.77	-83.1578	1.5	KY 134 bridge
		Salt River Basin (4/99 - 3/00)			
SRW002	Chaplin River	37.8912	-85.1995	16.8	KY 1754 bridge
SRW003	Bullskin Creek	38.241	-85.2901	10.3	Scott Station - Antioch Road bridge
SRW004	Simpson Creek	37.9826	-85.3665	2.1	sampled off KY 652
SRW005	Sinking Creek	37.8691	-86.3881	14.8	KY 86/ 261 at Clifton Mills
SRW006	Harrods Creek	38.3617	-85.5749	6.8	KY 329 bridge
SRW007	Clear Creek	38.2528	-85.2007	17.5	above Shelby Lake, KY Hwy 55
SRW008	Currys Fork	38.3074	-85.4506	0.3	KY 1408 bridge
SRW009	Big South Fork	37.4886	-85.1322	2.1	Old Lick Creek Road bridge
SRW010	Wilson Creek	37.8586	-85.6094	12.2	Mt. Carmel Church Road ford
SRW011	Doe Run	37.9501	-86.1298	6.1	Doe Run Inn bridge
		Upper Cumberland River Basin (4/00 - 3/01)			
CRW008	Marrowbone Creek	36.7864	-85.4202	1.2	near Burkesville, KY Hwy 691
CRW009	Crocus Creek	36.8655	-85.3388	2.3	near Amandaville, county road
CRW010	Roundstone Creek	37.2987	-84.2137	0.5	at Livingston, KY Hwy 490
CRW011	Middle Fork Rockcastle River	37.3438	-84.0807	5.9	near Parrot, KY Hwy 2002
CRW012	South Fork Rockcastle River	37.2963	-84.0932	5.1	near Cornette, Bad Hill Rd
CRW013	Little Laurel River	37.0175	-84.1114	1.5	near mouth, KY Hwy 552
UCTMDL01	Little Laurel River	37.1029	-84.0558	12.7	KY 1006 bridge
CRW014	Laurel River	37.042	-84.0483	34.2	near Lily, Happy Hollow Rd
CRW015	Marsh Creek	36.7439	-84.371	7.1	near Whitley City, Laurel Creek Rd
CRW016	Jellico Creek	36.7271	-84.2675	5.2	near Williamsburg, KY Hwy 478
CRW017	Richland Creek	36.9029	-83.8897	3.5	near Barbourville, Old Railroad Grade Rd
CRW018	Straight Creek	36.7734	-83.6699	1.6	at Pineville, KY Hwy 66
CRW019	Yellow Creek	36.7101	-83.6447	1.0	near Ponza, KY Hwy 1534
CRW020	Poor Fork Cumberland River	36.8933	-83.2656	5.1	at Rosspoint, U.S. Hwy 119
CRW021	Clover Fork	36.8609	-83.2917	4.0	at Golden Ash, KY Hwy 58
CRW022	Martins Fork	36.8325	-83.3265	1.0	at Harlan, Sunshine Rd
		Lower Cumberland/Tennessee/Mississippi River Basins (4/00 - 3/01)			
JPTMDL01	Clarks River	36.6917	-88.2735	49.0	at Dexter, KY Hwy 1346
TRW001	Cypress Creek	37.0292	-88.413	3.2	near Calvert City, McFarland Road
TRW002	Panther Creek .	36.8054	-88.5222	1.2	near Hicksville, McKendree Church Rd
JPTMDL02	Massac Creek	37.094	-88.7313	4.2	near West Paducah, KY Hwy 358
ORW001	Shawnee Creek Slough	37.0151	-89.097	0.7	near Wickliffe, Corner Road
MRW001	Mayfield Creek	36.8191	-88.6305	35.3	near Hickory, West Plains Road
MRW002	Wilson Creek	36.9336	-88.8853	0.7	near Cunningham, KY Hwy 1820
MRW003	Obion Creek .	36.6494	-89.1223	8.5	at Whaynes Corner, Whaynes Corner Rd
MRW004	Terrapin Creek	36.5086	-88.4991	3.5	near Bell City, Alderdice Road
CRW005	Whippoorwill Creek	36.6972	-86.9633	4.3	near Dot, KY Hwy 2375
CRW004	West Fork Red River	36.6516	-87.3777	16.3	near Cadiz, Carter Road
LCTMDL01	South Fork Little River	36.8000	-87.4983	1.3	near Hopkinsville, Riverbend Rd (TMDL)
LCTMDL02	North Fork Little River	36.8019	-87.5144	0.1	near Hopkinsville, Gray Lane (TMDL)
CRW002	Muddy Fork	36.9138	-87.8442	7.5	near Cadiz, KY Hwy 139
CRW003	Sinking Fork	36.8408	-87.7409	4.2	near Cadiz, Kings Church Road
CRW001	Livingston Creek	37.143	-88.1633	5.8	near Dycusburg, KY Hwy 295

continued to sample 21 sites in the Upper Cumberland River basin on nine streams and three streams in the Northern Kentucky area with long-standing swimming advisories.

Biology. Unlike water quality monitoring, there was a relative abundance of resources available for biological monitoring. For targeted monitoring, these resources allowed sampling at 171 sites in the Salt/Licking unit (104 in the Licking River basin and 67 in the Salt River basin) in 1999, and 302 sites in the Cumberland unit (171 in the upper part of the unit and 131 in the lower part) in 2000. Also, a random or probabilistic survey approach was used to characterize wadeable (first to fifth-order) streams in the two basin management units by sampling macroinvertebrates at 125 sites.

For the watershed biological monitoring network, targeted stations were placed in the downstream reaches of fourth-order (on 1:24,000 scale USGS topographic maps) watersheds. One reason for this choice was that the number of fourth-order watersheds fairly closely matched the available monitoring resources. Another favorable attribute of fourth-order watersheds is that they are more hydrologically accurate and uniform in size than 11-digit watersheds. Most fourth-order streams were monitored for at least one component of the biological community (fish, macroinvertebrate, algae) and habitat.

In the Salt/Licking unit in 1999, the Kentucky Department of Fish and Wildlife Resources (KDFWR 2000) sampled fish at 93 stations, and the DOW collected fish, macroinvertebrates, and algae at 25 stations. Eastern Kentucky University (EKU) was funded by a Section 319(h) grant to perform additional biological work in the Salt River Basin (Schuster et al. 2000). The U.S. Forest Service (USFS 2000) and Kentucky State Nature Preserves Commission (2000) collected macroinvertebrate samples at 13 and 8 stations, respectively.

In the Cumberland unit in 2000, the DOW collected multi-assemblage data from 37 sites in the Upper Cumberland basin and 8 sites in the lower portion of the basin unit (Figures 3-4, 3-5, and 3-6). The KDFWR (2001) collected fish at 93 sites. The USFS sampled ten sites in 1999-2000, and assessments from previous sampling were carried forward for several other streams in the national forest. In addition, 319(h) nonpoint source grant monies were used to contract: 1) Murray State University for macroinvertebrate sampling at 47 sites in the lower Cumberland and Tennessee river basins (White et al. 2001a and 2001b); 2) EKU to collect fish and macroinvertebrates from the Upper Cumberland River basin at 5 sites in the upper Buck Creek

basin in Lincoln and Pulaski counties (Moeykens and Schuster 1997); and 3) EKU to collect fish, macroinvertebrates, and mussels at 6 sites in the Sinking Creek watershed in Laurel County (Groves and Schuster 2000). The U.S. Army Corps of Engineers Nashville District contracted macroinvertebrate work at 17 inflow and 2 tailwater sites of Martins Fork, Laurel, Cumberland, Dale Hollow, and Barkley lakes (Pennington & Associates, Inc. 2000). TVA also collects routine biological data at several sites on tributaries to Kentucky Lake (Tennessee River) in Kentucky. Ten streams were sampled for fish in 1999-2000 (Tennessee Valley Authority 2001), and data collected in 1996 and assessed for the 1998 305(b) report were carried over for several other streams.

The DOW conducted a random survey of wadeable streams using locations generated by the EPA Office of Research and Development in Corvallis, Oregon. The "probabilistic" monitoring design is employed to statistically assess aquatic life use support on the majority of Kentucky's waters. This effort is designed for a basin unit, with criteria provided to make a random, statistically valid selection of potential target streams to collect samples that will reflect the basin as a whole. Kentucky commonly defines the potential target stream population as wadeable (first through fifth-order) streams.

Network design and sampling procedures developed by EPA's Environmental Monitoring and Assessment Program (EMAP) were used in Kentucky's random survey. Sampling locations are selected from EPA's River Reach File 3 (essentially blue lines on a 1:100,000 USGS scale), which provides the framework. In the design process, the number of sample sites needed to satisfy the confidence limit of the 95^{th} percentile are determined so statistically valid extrapolation of the data can be made for the whole basin when assigning the miles of use attainment.

Once each segment is analyzed for use designation, calculations are made based on similar streams in the basin. For example, the results (full support, partial support and non-support) of first-order streams in the probabilistic assessment are extrapolated to total number of miles of first-order streams in the basin management unit, then second-order streams, etc. Nothing can be said about streams greater than fifth order in each basin, except for those stream reaches assessed by targeted sampling. Reaches typically extend from one significant tributary to another; occasionally, land use or a point source discharge will be the reach terminus.